

Method and apparatus for stacking sheet material

[0001] The invention relates to a method for stacking sheet material as well as a spiral slot stacker, in particular for the use in a bank note processing apparatus.

[0002] In conventional bank note processing machines the bank notes generally are singled in a stack and led past a sensor device by means of a transport path. The individual bank notes are checked by sensors of the sensor device and dependent on the checking result are supplied to certain final destinations or stacker units.

[0003] For checking the bank notes several sensors can be provided, which judge the bank notes according to different criteria. Accordingly, several stacker units are available, which stack the bank notes of the different categories into units of an adjustable piece number. If for example bank notes of a certain category are to be stacked in units of a piece number of 100 bank notes, it is necessary to perform a separation in the continuous flow of bank notes between the one hundredth bank note and the following bank note meant for the same stacker after the one hundredth bank note has arrived at the stacker.

[0004] In connection with this, from DE-PS 34 12 725 it is known to use two stackers for bank notes of the same category. If 100 bank notes are placed in the respectively active stacker, the following bank notes will be supplied to the second identically constructed stacker via a diverter in the transportation system. In this known solution it is necessary to provide two stackers of the same construction and the respective required space.

[0005] From EP-OS 0 119 814 is known a solution, which requires only one stacker per bank note category. For this purpose on the stacker is provided a separation element. At first this separation element is in an idle position until, analogously to the above-mentioned example, 100 bank notes have been stacked. After that the separation element is inserted into the flow of bank notes between the one hundredth bank note and the bank note following thereupon in such a way, that the following bank notes are temporarily stored on the separation element. Meanwhile, the stacked unit of bank

notes can be emptied. After the emptying the temporarily stored bank notes are stored in the stacker. The separation element returns to its idle position.

[0006] This solution has the disadvantage, that with higher transportation speeds a relatively high actuating power for accelerating the separation element has to be summoned, which can only be achieved with a correspondingly high effort. With such a high transportation speed a reliable operation of the stacker cannot be guaranteed.

[0007] In DE 44 37 722 A1 it is proposed to interrupt the delivery of bank notes to the transportation system instead, when the sensor device detects that the predetermined piece number of a category has been reached. The bank notes of the same category already singled at this point of time are temporarily stored in the sorter, until the ready stacked bank-note stack has been removed. The temporary storage can be performed in the stacker itself or in a buffer path integrated in the transport path. This solution has the general disadvantage that the machine due to the interruption works in a discontinuous fashion.

[0008] In the solution in which the already singled bank notes are stored in the stacker itself, the stacker has the form of a spiral slot stacker; as for example described in DE-OS 32 32 348. However, the stripper for stripping out the bank notes accommodated in the slots of the stacker wheel is designed to be movable in such a way that it can be moved out of the stacker wheel or into the stacker wheel. The components interact with each other in such a way that the movable stripper when moving out of the stacker wheel strips out the one hundredth bank note onto the stack deposit, and that the bank notes located in the next slots of the stacker remain therein. In the meantime, the stacker wheel further rotates and accommodates the bank notes which had already been singled at the point of interruption. As soon as the stack deposit is emptied and prepared for stacking a next bank-note stack, the stripper again is moved into the stacker wheel. Then the stacking operation is continued in the usual fashion.

[0009] The disadvantage in this solution is that the stacker wheel has to be stopped, so as to enable the stripper to move again into the stacker wheel. Because with a rotating stacker wheel there exists the danger that the stripper collides with the bank

notes located in the slots, before it has reached its strip-out position. However, this means that the transportation system does not only have to be interrupted as soon as the predetermined piece number of a category has been reached, but potentially once again when the stripper is moved back into the stacker wheel.

[0010] It is the problem of the present invention to propose a method and an apparatus for stacking sheet material, in which the delivery of bank notes to the transportation system not necessarily has to be interrupted when the predetermined piece number of a category has been reached, or that such an interruption time at least is kept short.

[0011] This inventive solution starts out from a spiral slot stacker according to DE 44 37 722 A1, in which the sheet material is temporarily stored in the stacker wheel. I.e., for example the one hundredth bank note is stripped out from the stacker wheel by means of a movable stripper, while the bank notes in the next slots remain in the stacker wheel. In so far herewith reference is made to DE 44 37 722 A1 including the constructive proposals for solution described therein.

[0012] As to prevent the stripper from colliding with the bank notes located in the stacker wheel when moving into the stacker wheel or having to stop the stacker wheel as to avoid such a collision, the stripper is formed at least in a two-part fashion, only a first part being moved out of the stacker wheel in the described fashion. At the time the first part of the stripper is moved out of the stacker wheel, the second part of the stripper is released from its strip-out position. The second part of the stripper is movable, too. It is, however, not moved out of the stacker wheel but rotates along with the stacker wheel after having been released from the strip-out position. Meanwhile, further bank notes are supplied to the stacker wheel, in such a way that the delivery of bank notes to the transportation system of the bank note processing machine has not to be interrupted.

There are two alternative embodiments:

[0013] According to the first embodiment, the second part of the stripper rotates along with the stacker wheel until the stack deposit is prepared to receive a next bank-

note stack and the second part of the stripper again has reached its strip-off position. Then it is again locked in the strip-off position, the stacker wheel still further rotating. By this means it is achieved that the bank notes located in the stacker wheel are stripped out of the stacker wheel and stacked on the stack deposit by the second part of the stripper beginning with the moment of locking. Now the first part of the stripper can be moved back to its strip-out position on the same path on which it has been moved out of the stacker wheel. A collision with the bank notes located in the stacker wheel is excluded, since these are stripped out of the stacker wheel by the second part of the stripper.

[0014] However, in this solution, too, in rare cases it can occur, that a bank note provided for the spiral slot stacker cannot be introduced into a slot of the stacker wheel, this is the case when the supply is blocked by the moved-along second part of the stripper. Only few slots of the stacker wheel are affected by this blocking. The problem can be easily avoided by driving the stacker wheel in an accelerated fashion in this phase, so as to the respective slots are rapidly turned past the bank note supply position. If this is not sufficient as to avoid a collision of a bank note to be supplied to the stacker wheel with the rotating-along part of the stripper, it is expedient to integrate a buffer path into the transport path, as it is proposed in DE 44 37 722 A1 as a second alternative. In so far, too, reference is made to DE 44 37 722 A1.

[0015] According to the second embodiment the second part of the stripper rotating along with the stacker wheel is moved back to its strip-out position against the rotating direction of the stacker wheel and locked. This has the advantage that it is not moved past the bank note supply place and the supply of further bank notes to the stacker wheel thus is not blocked. However, this second embodiment is only practicable, when the second part of the stripper has not moved too far away from the stack deposit, since though the bank notes are stripped out of the slots when the second stripper part is moved back, they would not be stacked on the stack deposit in a reliable fashion. With this embodiment, therefore, it is important that the stack deposit is prepared as rapidly as possible for receiving the next bank-note stack to be stacked. This can be achieved, for example, by pushing aside the ready stacked bank-note stack or, according to a preferred embodiment, by moving an auxiliary stack deposit over the

stack deposit with the ready stacked bank-note stack. As soon as the auxiliary stack deposit has taken its position, the moved-along second part of the stripper can be moved back to its strip-out position, the bank notes located in the stacker wheel slots in between being stripped out onto the auxiliary stack deposit. Then, again the first part of the stripper, which was moved out of the stacker wheel, is moved back into the stacker wheel. Then the stacking operation is continued in the usual fashion.

[0016] The auxiliary stack deposit and the stack deposit preferably are designed in the manner of a rake in such a way that they can be brought to the same level when the ready stacked bank-note stack has been removed from the stack deposit.

[0017] In the following the invention is described by way of example with reference to the accompanying figures.

[0018] Figures 1a to 1d show a first embodiment of the invention,

[0019] Figures 2a and 2b show a second embodiment of the invention and

[0020] Figures 3a and 3b show a third embodiment of the invention.

[0021] Figures 1a and 1d show a spiral slot stacker of a bank note processing machine at different points of operation. The bank note processing machine not shown in detail herein is constructed in a way as described in DE 44 37 722 A1, including transport systems, diverters, sensors and the like. Of course, the spiral slot stacker described in the following is also suitable for stacking sheet material in other apparatuses.

[0022] The spiral slot stacker has a stacker wheel 1 with slots spirally disposed one behind the other around a rotational axis. The rotating direction of the stacker wheel is indicated by an arrow. To the stacker wheel 1 bank notes 98 to 104 are supplied successively. Figure 1a shows the spiral slot stacker 1 just at the time the bank note 104 is supplied.

[0023] A stripper 2 in a usual fashion engages with the spiral slot stacker. For this purpose the slots accommodating the bank notes are formed by stacker wheel fingers 3 disposed side by side and spaced apart from each other, between which the stripper 2



with stripping fingers suitably adapted and disposed side by side moves into engagement. In Figure 1a the spiral slot stacker is schematically shown in section, in such a way that merely one stripping finger and one stacker wheel finger plane is shown.

[0024] Due to the rotation of the stacker wheel 1 and the rotation of the stripper 2 engaging with the stacker wheel 1 the bank notes located in the stacker wheel 1 are transported towards the stripper 2, which successively strips out these bank notes from the slots of the stacker wheel 1 onto a stack deposit 4 located therebelow. By this means on the stack deposit 4 is formed a bank-note stack 5, to which at the time as shown in Figure 1a the 98th bank note 98 is supplied.

[0025] When the number of bank notes required for the bank-note stack 5, for example 100 bank notes, is reached, the stacking operation is interrupted, so that the bank-note stack 5 can be taken out from the stack deposit 4, before the stacking of the next bank-note stack begins. For this purpose the stripper 2, as described in DE 44 37 722 A1, is moved out of the stacker wheel 1 in such a specific way that the one hundredth bank note 100 is the last to be stripped out from the stacker wheel 1 onto the bank-note stack 5, as indicated in Figure 1b.

[0026] In contrast to DE 44 37 722 A1, however, only a part 2a of the stripper 2 is moved out of the stacker wheel 1 roughly in the direction of the shown arrow, while a second part 2b of the stripper is moved along with the rotating stacker wheel 1. For this purpose each stripping finger of the stripper 2 is divided into two parts 2a, 2b. Alternatively, every second stripping finger can be designed as a moved-along stripping finger 2b and the remaining stripping fingers as stripping fingers 2a adapted to be moved out.

[0027] The movement of the stripper part 2a by suitable measures is correlated with the rotation of the stacker wheel 1 in such a way that the desired purpose is achieved, namely to strip out a specific bank note as a last bank note and to leave the next bank note in the stacker wheel. For this purpose the stripper part 2a can have a separate, electronically controlled drive or be designed to be mechanically coupled to a contour disk, as described in DE 44 37 722 A1.

[0028] A not shown locking of the second part 2b of the stripper 2 for fixing it in the strip-out position as shown in Figure 1a is released at the time the first part 2a of the stripper 2 is moved out of the stacker wheel 1. As to achieve the result that the second part 2b of the stripper 2 rotates along with the stacker wheel 1, there can be provided a separate drive. But the effort connected with a separate drive can be avoided, when the second part 2b of the stripper in the moment of being released from the locking is coupled to the stacker wheel 1. For this purpose the stripper is connected to the driving shaft of the stacker wheel 1 via a not shown coupling and locked in its strip-out position by means of a release mechanism or is released via the release mechanism after having stripped out the one hundredth bank note, so that it synchronously rotates with the stacker wheel 1. Instead of a mechanical release mechanism the coupling can have the design of a magnetic coupling adapted to be electrically actuated.

[0029] Figure 1c shows the stacker wheel 1 with the rotating-along part 2b of the stripper 2 and the first part 2a of the stripper 2, which is completely moved out of the stacker wheel 1, after the one hundredth bank note 100 was stripped out onto the bank-note stack 5. Meanwhile, the 106th bank note 106 is transported to the stacker wheel 1.

[0030] Now the bank-note stack 5 is removed from the stack deposit 4, so as to prepare the stack deposit for receiving the next bank-note stack. After having prepared the stack deposit 4 for receiving a next bank-note stack, the stacker wheel 1 further rotates until the second part 2b of the stripper 2 again has reached the strip-out position according to Figure 1a. This is shown in Figure 1d. Since in the meanwhile further bank notes 107 to 112 have been supplied to the stacker wheel 1, in individual slots of the stacker wheel 1 are located two or, optionally, more bank notes, when the second part 2b of the stripper 2 again reaches its strip-out position. The second part 2b of the stripper 2 then again is locked in the strip-out position, in such a way that the bank notes located in the slots of the stacker wheel are stripped out onto the stack deposit 4 by the second part 2b of the stripper 2 in the usual fashion. Then the first part 2a of the stripper 2 can be moved back to the strip-out position, too. A collision with the bank notes located in the stacker wheel is not possible here, since in the meanwhile these bank notes are stripped out by the second part 2b of the stripper 2. For this reason, in

particular the stacker wheel 1 needs not to be stopped, when the first part 2a of the stripper 2 is moved back to the strip-out position.

[0031] In Figure 2a and 2b a second embodiment of the spiral slot stacker is shown, which in principle works in the same way as the embodiment previously described with respect to the Figures 1a to 1d. Figure 2a shows the stacker wheel 1 at the same time of operation as in Figure 1c. The procedure of the method in so far is identical. In contrast to the embodiment according to Figures 1a to 1d, after completing the bank-note stack 5 by stripping out the one hundredth bank note 100, an auxiliary stack deposit 6 is introduced between the stacker wheel 1 and the bank-note stack 5, in such a way that the spiral slot stacker is considerably faster prepared for stacking a next sheet material stack. By this means the moved-along second part 2b of the stripper again can be locked in the strip-out position as early as after one revolution of the stacker wheel 1.

[0032] Preferably, the stack deposit 4 and the auxiliary stack deposit 6 are designed in a comblike fashion. At first the stack deposit 4 together with the bank-note stack 5 is lowered, so that the auxiliary stack deposit 6 can be positioned thereabove. After the bank-note stack 5 has been removed from the stack deposit 4, the stack deposit is lifted to the level of the auxiliary stack deposit 6 with the bank notes 101, 109, 102, 110 etc. temporarily stored thereon to the level of stack deposit 4 in such a way that the teeth of the two deposits 4 and 6 engage in a comblike fashion and constitute a joint deposit level. As to prevent a collision of the auxiliary stack deposit 6 with the first part 2a of the stripper 2 moved out of the stacker wheel 1, the introduction of the auxiliary stack deposit 6 is performed, for example, in a direction parallel to the axis of rotation of the stacker wheel.

[0033] As recognizable from Figures 1a to 1d and 2a, 2b, the supply of further bank notes to individual slots of the stacker wheel 1 is temporarily blocked by the second part 2b of the stripper 2 which is rotating along with the stacker wheel 1. If these slots cannot be moved past the bank note supply location, before the stacker wheel 1 is supplied with a next bank note, this next bank note has to be temporarily stored, for example in a buffer path integrated in the transport path. The technical effort required



for such a buffer path can be avoided, when the spiral slot stacker is designed as shown in Figures 3a, 3b. Here again the auxiliary stack deposit 6 is employed, which enables the beginning of stacking a next bank-note stack even before the bank-note stack 5 has been removed from the stack deposit 4.

[0034] Figure 3a shows the spiral slot stacker in the same position as in Figure 2a. In contrast to the embodiments described until now, the second part 2b of the stripper 2, however, is moved along with the stacker wheel 1 only as long as the one hundredth bank note 100 has been stripped out onto the stack deposit 4. Then the stack deposit 4 is lowered, the auxiliary stack deposit 6 is positioned over the lowered stack deposit 4, and the second part 2b of the stripper 2 is moved back to the strip-out position in an opposite direction as the rotating direction of the stacker wheel 1. Figure 3b shows the stacker wheel 1 with the second part 2b of the stripper 2 moved back to the strip-out position and the introduced temporary stack deposit 6. The stripping out of the first bank note 101 for the next bank-note stack begins with the moving back of the second part 2b of the stripper 2 to the strip-out position and is completed roughly at the time when the auxiliary stack deposit 6 has reached its position for stacking the next bank-note stack.

[0035] Now the first part 2a of the stripper 2, without a danger of collision with the bank notes located in the stacker wheel 1, can be moved into the stacker wheel 1. After the bank-note stack 5 being removed from the deposit plate 4, the stack deposit 4 is lifted in the fashion described hereinbefore to the level of the auxiliary stack deposit 6, and the said auxiliary stack deposit can be moved out of its comblike engagement with the stack deposit 4.